Stat 341 Lecture 1

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Introducing R

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Introducing R

What is R?

- R is an open-source environment for statistical computing and graphics.
  - An implementation of the S language (`https://en.wikipedia.org/wiki/S_(programming_language)`)
- Started in the mid-1990's by Ross Ihaka and Robert Gentlemen at Auckland University
- Now maintained by a team of experts called the R Development Core Team
- A "packages" system allows any user to bundle R code, data and examples together.
- R and R packages are distributed through the Comprehensive R Archive Network (CRAN).
- SFU has a CRAN mirror at `http://cran.stat.sfu.ca`

What does "environment" mean?

- R is a fully-functioning programming environment with all the usual constructs, such as
  - conditionals (if-then-else),
  - loops
  - user-defined functions.
- In addition there are built-in facilities for
  - data input, storage, manipulation, and output
  - optimization, matrix computation, etc.,
  - random number generation,
  - data analysis and graphics.
- "Base" R is good, but it is the package system that makes R great.

R packages

- The R package system is the key to R's success
- It has allowed statisticians and other data scientists to implement and distribute their work to be used by others.
- The R package system enforces some rules about how packages are structured, but differences in programming styles of package authors mean different interfaces
  - Users need to be aware of different data structures for input, output and of different styles of graphics

Course objectives

Course objectives

- Understand basic R data structures and programming
- Learn how to use base R and R package functions for data management, exploration, presentation and analysis
- Or, ...
  - learn enough R to get by in SFU Stat courses and write "proficient in R" on your resume

Getting started

Getting started with R, RStudio and git

- A brief set of instructions are on the canvas page `https://canvas.sfu.ca/courses/30477/pages/getting-started-with-r-rstudio-and-git`
- More details can be found in Appendix B.1 of the text.

R reference cards

Here are two. A google search will turn up many more.

- `http://cran.stat.sfu.ca/doc/contrib/Baggott-refcard-v2.pdf`
- `http://cran.stat.sfu.ca/doc/contrib/refcard.pdf`

Starting R

- Start R by starting RStudio.
- The "Console" window is where you can type your commands.
- However, it is good practice to open an R script, type your commands in the script, and then submit the commands to the R console.
  - `Session -> Set Working Directory` to set the working directory
  - `File -> New File -> R Script` to open a new R script
  - type your commands into the script
  - put your cursor on the line you want to submit and hit `Ctrl-enter`
- Save your script for later use.
- More on the RStudio interface at `https://support.rstudio.com/hc/en-us/sections/200107586-Using-RStudio`

Quick-start R

R as a calculator

```
2+4
```

```
## [1] 6
```

```
5*6
```

```
## [1] 30
```

```
x<-6
x*5
```

```
## [1] 30
```

- The assignment operator <- assigns the value 6 to the variable x

R for matrix computation

```
A <- matrix(c(1,2,3,4),nrow=2,ncol=2)
A
```

```
##      [,1] [,2]
## [1,]    1    3
## [2,]    2    4
```

```
x <- c(5,6)
b<- A %*% x
b
```

```
##      [,1]
## [1,]   23
## [2,]   34
```

- Type `help(matrix)` or `?matrix` for help on the `matrix()` function.
- The %*% operator is matrix multiplication: `help("%*%")`.

Matrix computation, continued

```
solve(A,b) # Solve Ax = b for x
```

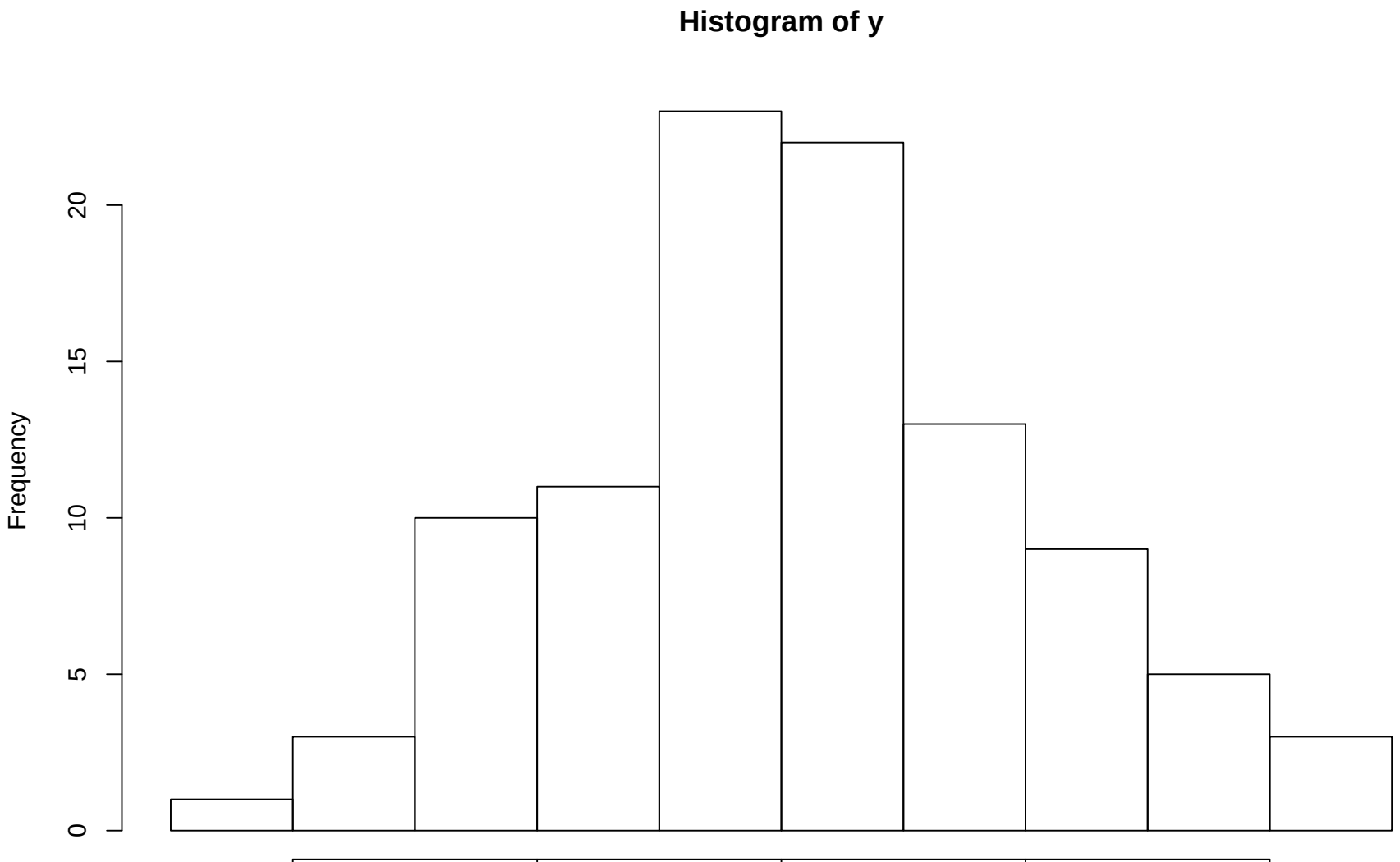
```
##      [,1]
## [1,]    5
## [2,]    6
```

```
solve(A) # A inverse
```

```
##      [,1] [,2]
## [1,]   -2  1.5
## [2,]    1 -0.5
```

Random number generation

```
set.seed(123) # optional, but makes computation reproducible
n<-100
y<-rnorm(n,sd=1)
hist(y)
```



R data

```r
data(cars) # load a built-in example dataset, help(cars) for info
head(cars) # look at the first few rows
```

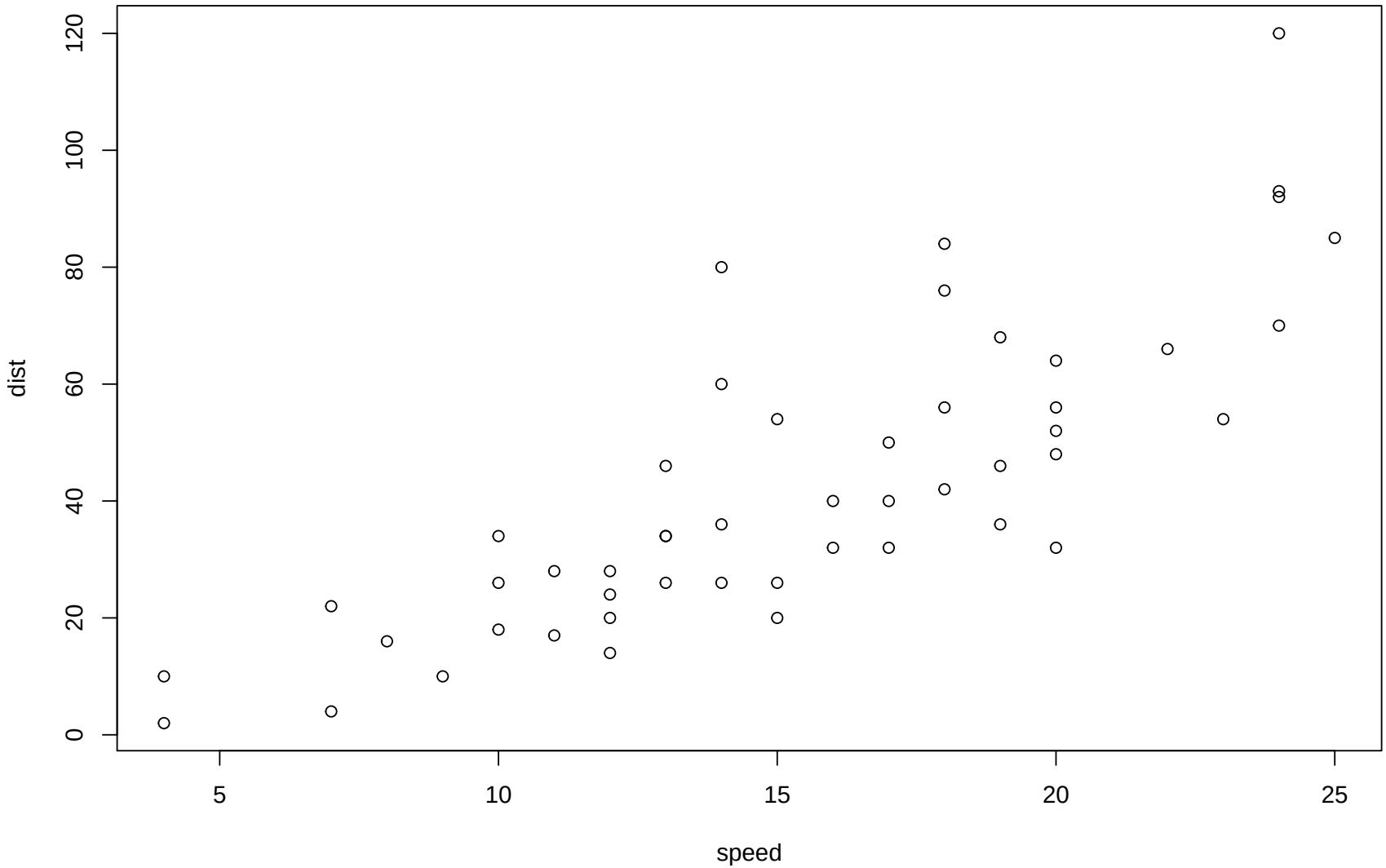
```
##   speed dist
## 1     4    2
## 2     4   10
## 3     7    4
## 4     7   22
## 5     8   16
## 6     9   10
```

```r
summary(cars) # summarize the variables
```

```
##      speed           dist
##  Min.   : 4.0   Min.   :  2.00
##  1st Qu.:12.0   1st Qu.: 26.00
##  Median :15.0   Median : 36.00
##  Mean   :15.4   Mean   : 42.98
##  3rd Qu.:19.0   3rd Qu.: 56.00
##  Max.   :25.0   Max.   :120.00
```

Plotting data

```
plot(cars)
```



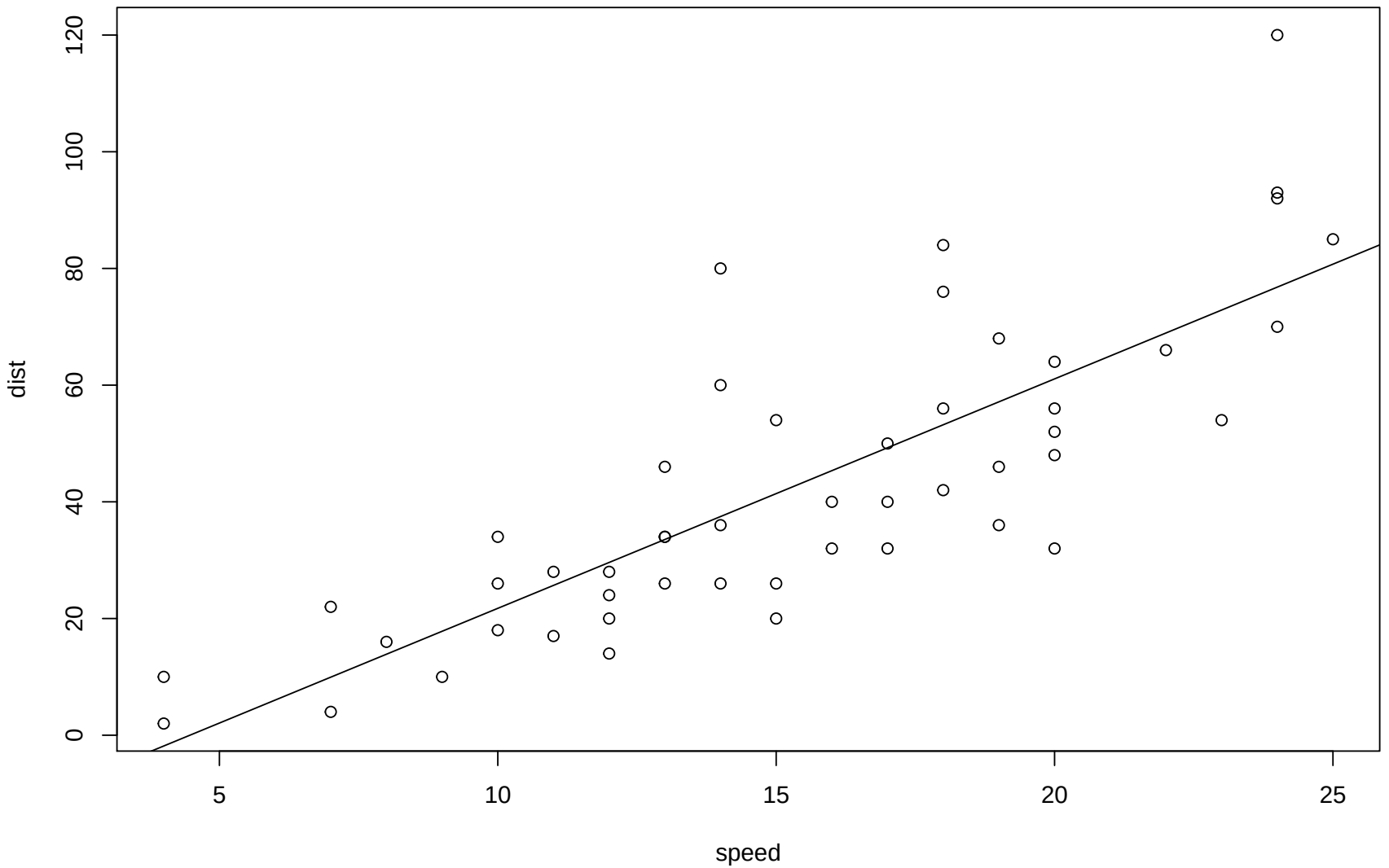
Modelling

```r
fit <- lm(dist~speed,data=cars) # fit a linear model, help(lm)
summary(fit)
```

```
##
## Call:
## lm(formula = dist ~ speed, data = cars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -29.069  -9.525  -2.272   9.215  43.201
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -17.5791     6.7584  -2.601   0.0123 *
## speed         3.9324     0.4155   9.464 1.49e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 15.38 on 48 degrees of freedom
## Multiple R-squared:  0.6511, Adjusted R-squared:  0.6438
## F-statistic: 89.57 on 1 and 48 DF,  p-value: 1.49e-12
```

Modelling, continued

```
plot(cars)
abline(fit)
```



Extracting model components

```
head(residuals(fit))
```

```
##         1         2         3         4         5         6
##  3.849460 11.849460 -5.947766 12.052234  2.119825 -7.812584
```

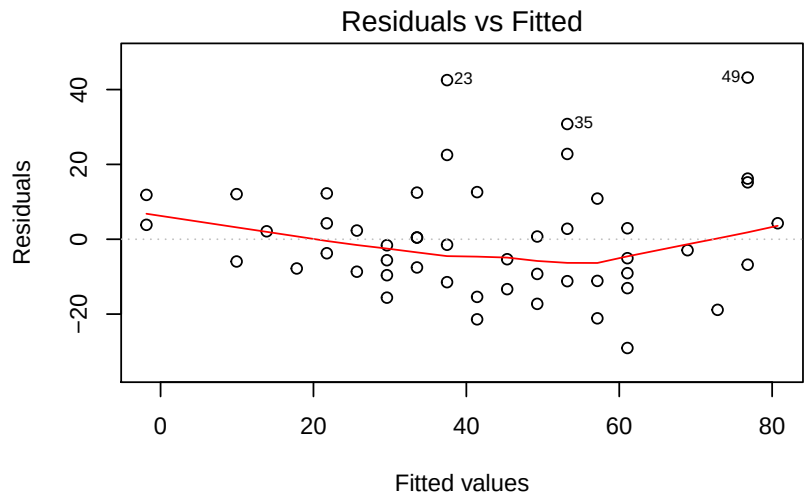
```
vcov(fit)
```

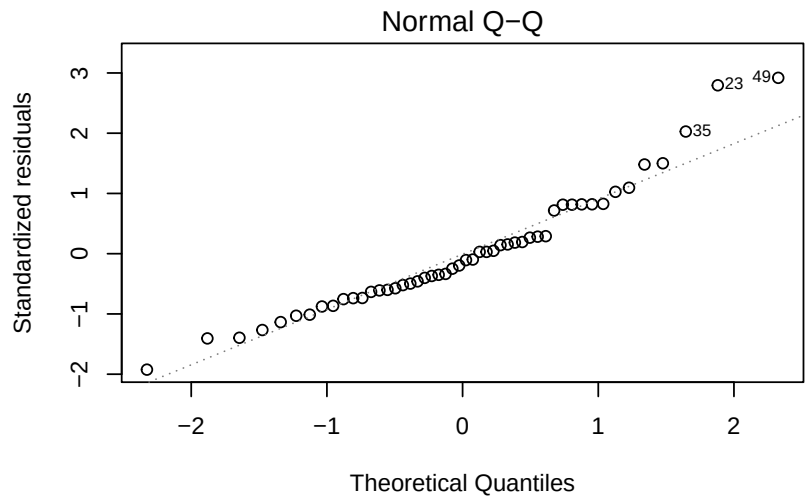
```
##             (Intercept)      speed
## (Intercept)   45.676514 -2.6588234
## speed         -2.658823  0.1726509
```

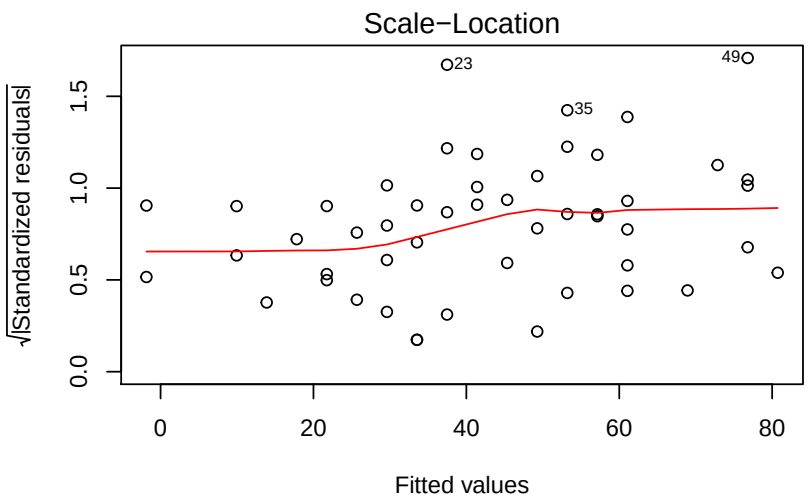
- See the help page for more components

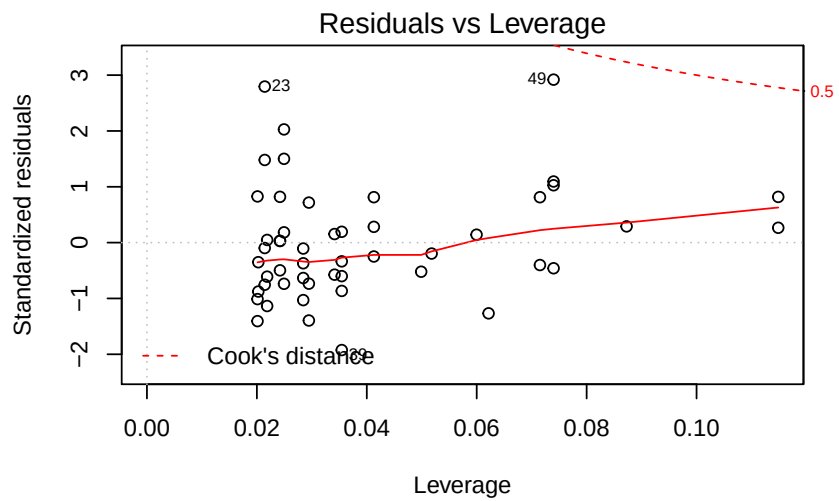
Model diagnostics

```
par(mfrow=c(2,2))
plot(fit)
```









Reading

Reading

- Text, Appendix B
- R and RStudio help pages/reference cards mentioned in this lecture